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United States Department of Agriculture.

DIVISION OF ENTOMOLOGY.

THE PEAR-TREE PSYLLA.

(*Psylla pyricola* Foerst.)

An overwhelming invasion of the pear-tree Psylla in the summer of 1894 in one of the largest pear orchards in Maryland, together with similar appearances in Virginia and New Jersey in the same year, gives prominence to an insect which had not previously been reported south of New York, although known to extend westward as



FIG. 1.—Pear-tree Psylla: adult female—natural size indicated by side line (original).

far as Michigan and to occur generally in the New England States. In view of its previous northern range, its sudden appearance in enormous numbers so far south was a matter of considerable surprise, and careful examinations of the work of the insect and experiments with remedies were made.

The pear-tree Psylla (fig. 1) is supposed to have been imported into Connecticut about 1832 from Europe, where this and one or two other species are well-known pear enemies. It is one of the true bugs of the order Homoptera, and its family, the Psyllidæ, is intermediate between or connects the scale insects and the plant-lice on the one hand with the Cicadas and larger plant bugs on the other. The Psyllidæ are commonly known as the jumping plant-lice, on account of the considerable vaulting ability of the adult insects.

NATURE OF THE INJURY.

The pear-tree Psylla has hitherto been by no means a common insect, and few pear growers are familiar with it. The insect, even in the later stages, is small and easily overlooked, but the effects of its presence upon the trees are startling enough, as seen in the falling of the leaves and fruit, the latter before it is half grown, but chiefly in the enormous secretion of honeydew by the larvæ and nymphs. One who has not witnessed this sight gives credence with difficulty to the reports of the amount of this liquid constantly being secreted. During the height of the invasion in Maryland the water-like fluid or honeydew was reported not only to have covered the leaves and twigs, but to have fairly rained from the leaves, and, running down the trunks, extended in a discolored circle for from 6 to 8 inches outward around the base of the trees. During cultivation the horses used became so drenched with the sticky substance that it became necessary to wash it off with sponges, the curry-comb being useless. The weakened trees lost much of their fruit, the leaves were blackened and fell in great numbers, and the bodies of the trees appeared as if they had been smoked.*

On July 20, when first seen by the writer, the leaves, limbs, and trunks were blackened by the growth in the sweetish liquid of the smoky fungus, *Fumago salicina*; and in the falling of the foliage and the diseased and smoky-looking fruit a startling picture of disaster was presented. The leaves were scarcely at all yellowed, but were covered with dead and dry patches or spots, sometimes investing almost the entire leaf, giving an appearance which might easily be mistaken for some fungous attack. This seems to be due not directly to the extraction of the plant juices by the insects, but rather to the sun-scalding resulting from the collection of the honeydew on the leaves in large drops. The Psylla was distributed over the entire orchard of upwards of 100 acres, but was much more abundant in the plats of older trees. The young orchards, perhaps amounting to one-third of the entire tract, were in vigorous condition, and had not been seriously affected. This was noticeably the case with the Kieffer, Buffon, Le Conte, and Standard Lawrence. The Dwarf Lawrence, on the contrary, was badly injured, and, with the old Duchess and Bartlett trees, seemed to have suffered the most.

OTHER OCCURRENCES SOUTH OF NEW YORK.

The presence of this pest, as recorded above, is not the first instance of its occurrence in Maryland. A pear orchard about 8 miles south of this one was also very badly infested in the summer of 1891. The insect appeared during that year on pear trees next to and in the vicinity of the house, where some nursery stock had been heeled in the winter previous. Its spread was confined to an area of 3 or 4 acres, which, however, was so thickly infested that the leaves and fruit fell, and the trees were so stunted and injured that they ceased bearing until the season of 1894, when they bore a fairly good crop. Curiously enough, however, in this orchard the Psylla disappeared entirely after the first year and has not again put in an appearance, nor did it occur in other pear orchards between and in the neighborhood of the two referred to. Similar outbreaks are reported this year for the first time in

* Chestertown (Md.) Transcript, July 19, 1894.

New Jersey by Prof. John B. Smith, with evidences of the same source of infestation, and about the middle of October it was found in Charlottesville, Va., by Mr. D. W. Coquillett. These records evidence an unfortunate tendency of the insect to spread southward—a course which, from the history of the pest during the sixty years of its occurrence in this country, was hardly to be expected.

METHOD OF INTRODUCTION.

The suddenness and severity of the appearance of the *Psylla*, particularly in the Maryland instances, makes the question of its introduction one of considerable interest. Upon inquiry it was developed that in these cases the pear trees had been obtained from a New York nursery in 1890, or just at the time when the *Psylla* appeared in such extraordinary numbers in New York State; and it is unquestionably from this source that the *Psylla* was introduced. The young trees secured in the fall of the year mentioned were undoubtedly infested with hibernating *Psyllas*, as it was in the immediate vicinity of the point where these trees were heeled in that the outbreaks occurred. In one case the insect seemed to have gradually increased in numbers, reaching a destructive abundance in the summer of 1894. The entire disappearance of the insect after the first year in the other orchard is probably to be explained on the ground of some local climatic condition. Such modifying influences are not unusual in the peach belt of Maryland, as illustrated by the fact that orchards separated by only a few miles, and with the same conditions as regards soil and variety of fruit, will seemingly be so differently affected by very local cold waves or storms that one will be barren while the other will be full of fruit.

DESCRIPTION AND LIFE HISTORY.

The stages in the development of this insect are the egg, the larva, the nymph or active pupa, and the adult or perfect winged insect. The egg (fig. 2, *a*) is orange-yellow in color and so minute as to be almost invisible to the naked eye. Its peculiar structure is indicated in the drawing—the short arm serving as its attachment to the leaf. The newly hatched larva is somewhat larger than the egg and yellow in color, with crimson eyes, and has the characteristics indicated at fig. 2, *b*. With each of the earlier molts the form approaches more and more nearly the nymphal stage, which is represented in its final form at fig. 3. In this stage the prominent features are the large wing pads. The general color is dark reddish-brown, with the lighter areas indicated in the illustration—the eyes remaining of a crimson color. In all the preparatory active stages the insect is broad-oval and very much flattened, little, if at all, resembling the adult, but rather some scale insect, and is very sluggish. The adult (fig. 1) comes from the last nymph, and is a little, clear-winged insect, closely resembling the Cicada or harvest fly vastly reduced. Like the latter, its wings close roofwise in repose. Its color is reddish-crimson, with the brown or black markings indicated in the illustration. The last or hibernating brood turns uniformly brownish black, with bronzy eyes and dark wing veins, and was described as a distinct species (*Psylla simulans*), but has been shown by Mr. Slingerland* to be merely a winter form, which result is confirmed by breeding records at this Department.

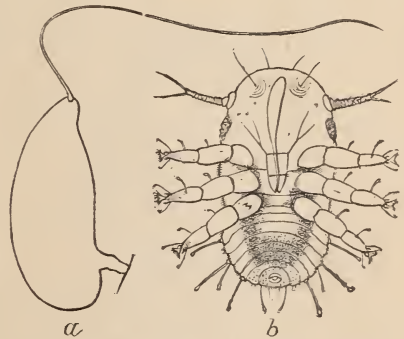


FIG. 2.—Pear-tree *Psylla*: *a*, egg; *b*, larva—both greatly enlarged (original).

* Bulletin 44, Cornell Agric. Exp. Station, Oct., 1892.

The life history of the insect may be briefly summarized as follows: The adults hibernate in crevices in the bark of pear trees* and emerge with the first warm spring days, copulate, and begin the deposition of eggs before the leaves have expanded, placing them singly or in rows or bunches in creases of the bark of the twigs, on old leaf scars about terminal buds, and later, after the leaves begin to unfold, on the leaves themselves, as already described. The egg laying goes on during April, probably later in the North than as far south as Maryland. The larvæ hatch in from ten to seventeen days (from ten to twelve days being the ordinary summer period), station themselves on the leaf petioles and in their axils on the fruit, but chiefly over the surface of the leaves. The moment they begin feeding the secretion of honeydew commences, and in a very short while the bulk of liquid will be several times that of the insect, rapidly increasing until it forms a good-sized drop. This, when there are millions to aid in the work, soon becomes abundant enough to fall as a shower from the tree whenever it is shaken by the wind. Mr. Slingerland shows that there are five molts, including the last change from the pupa to the adult insect, and the life from the laying of the egg to the adult covers a period of about thirty days, the periods between molts varying from three to seven days.

RECORD OF BROODS FOR MARYLAND.

The adults were very numerous July 20 in Maryland, frequently fifteen or twenty resting along the midrib of a single leaf. They were depositing their eggs along

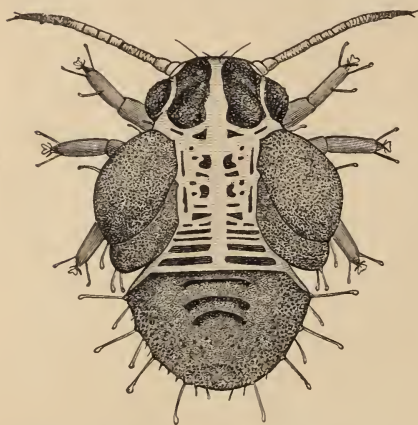


FIG. 3.—Pear-tree Psylla: nymph—greatly enlarged (original).

the midrib on the upper surface, and also thickly along the serrated margin, but on no other part of the leaf. From July 31 to August 3, when again examined, the eggs were much more numerous and had been frequently deposited in small clusters, five to eight together, along the midrib and at the margin of the leaves. Scarcely any of the eggs at this time had been hatched, at least not more than 2 or 3 per cent, and the adults were still almost as numerous as ever and busily ovipositing. This brood, which was the maximum one of the season, was with little doubt the third one from the hibernating individuals—a month being the normal period for a generation. A fourth brood of adults appeared about the last of August, and a fifth about the 1st of September. In breeding cages over

young potted pear trees no difficulty was experienced in getting the fourth and fifth broods in large numbers, but in the orchard on the mature foliage—prematurely mature, from the sapping of the insects—the fourth brood was very scanty in numbers, showing not more than one where there were a thousand before, and this in the face of the fact that more eggs had been deposited than for any previous brood. The further decrease with the fifth brood was as marked, and the greatest difficulty was experienced in finding a single adult.

THE FUTURE OUTLOOK.

Judging from the history of the pear-tree Psylla in the North, we may expect that the injury will be very much less in future, even if there is not an entire cessation of the trouble and a disappearance of the pest. The fact that this insect was im-

*On potted trees in an unheated greenhouse the adults rested exposed on the twigs all winter without making any attempt at concealment, and began ovipositing early in March, the first brood maturing early in April. The plants on which they wintered were, however, in time of leafing, fully four weeks in advance of those on the grounds.

ported into the United States with pear trees over sixty years ago and was long since widely distributed throughout the pear districts of the Northern States and westward to the Mississippi, and has yet, during all this time, rarely been reported as injuriously abundant, argues that the conditions favorable to its increase are seldom met with. Its complete disappearance in one orchard, after a year of excessive abundance, is a case in point; and the excessive multiplication in New York State in 1891 was followed the next year, according to Mr. Slingerland, by scarcely any injury in comparison. The reasons for the sudden multiplication and quite as sudden disappearance of this pest are difficult to give. A succession of two or three winters favorable to hibernation probably leads to the unusual increase, and the resulting attack brings the trees into a condition which is probably prejudicial to the insect. With the later summer broods, as pointed out above, the condition of the leaves which have been seriously attacked by the earlier broods is such that the insect becomes markedly less abundant later in the season. The green, succulent foliage of the young spring growth is especially favorable, and when the leaves

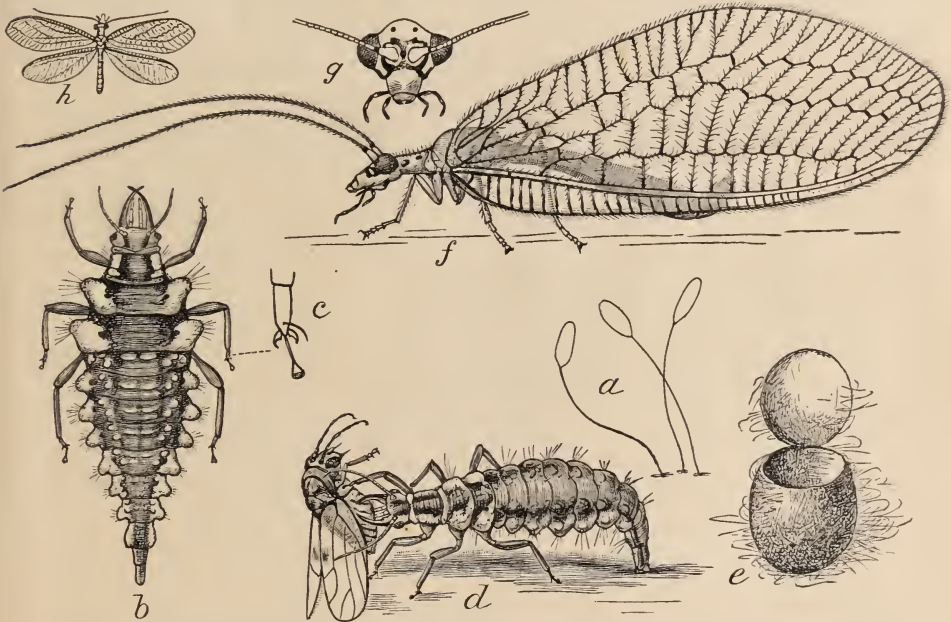


FIG. 4.—*Chrysopa oculata* Say: a, eggs; b, full-grown larva; c, foot of same; d, same devouring a Psylla; e, cocoon; f, adult insect; g, head of same; h, adult, natural size—all enlarged except h (original).

become hardened and mature, and especially dry and innutritious, from having been already sapped of their vitality, they are distasteful and unsuited to the development of the later broods.

The parasitic and predaceous insects also become very efficacious by midsummer, and a very interesting experience in the case of the Maryland invasion will be now noted.

NATURAL ENEMIES.

No enemy for this insect among the parasitic and predaceous species has, previous to this year, been recorded. On my first visit to the Maryland orchard I was shown what was taken to be the egg of the Psylla, which proved, however, to be the egg of a common lace-winged fly, *Chrysopa oculata* Say. The mistake was a very natural one, for the eggs occurred in extraordinary numbers throughout the orchard. On some trees nearly every leaf would have one or two of the eggs of the *Chrysopa*

attached to it. Later nearly full-grown larvæ of the *Chrysopa* were found on the pear trees, attacking and devouring the adult *Psylla* in a very vigorous manner (see fig. 4, *d*), and the young larvæ were found to feed with great readiness on both the eggs and the young larval *Psyllas*. It is a safe estimate to say that one lace-wing fly larva will destroy several hundred eggs and larvæ of the *Psylla*, in addition to the adults which it will destroy in its later larval growth. The great abundance of the *Chrysopa* eggs on the pear trees makes it not at all improbable that the lace-winged fly had much to do with the marked decrease in the later broods of the *Psylla*.

The predaceous habits of the lace-wing fly larvæ are of common record, and their beneficial character is well known; but in view of the important rôle played by this

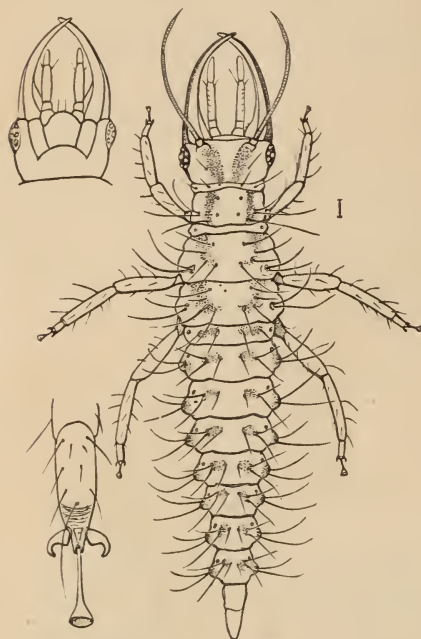


FIG. 5.—*Chrysopa oculata*: newly hatched larva, with under side of head and claw at side—greatly enlarged (original).

insect in the economy of the *Psylla*, its life habits may be briefly summarized. The eggs (fig. 4, *a*), instead of being deposited in rather numerous placed clusters or groups, as is the case with some other species, are distributed almost invariably singly on the leaves, rarely two together on the same stalk. The young larva (fig. 5) cuts off the upper end of the egg on emerging, and is surprisingly large in comparison with the egg from which it emerges. It is light ash-gray in color, the head abnormally large, and the body armed with immense curved hairs or spines, which give it rather a ferocious appearance and undoubtedly make it seem to the young *Psylla* a veritable dragon. It crawls down the egg stalk and begins immediately its active search for food. On approaching the egg or young larval *Psylla*, it immediately grasps it between its long, curved, mandible-like organs, which amount to two sucking tubes, between the tips of which the egg or the young larva is held and rolled one way and the other, as between thumb and finger, the juicy contents being in the meantime rapidly extracted.

It is a most interesting sight to watch

this little larva at work and to note with what celerity it grasps the young *Psylla*, quickly extracts the juices, and casts aside the dry shell, the whole operation frequently taking less than a minute.

The larva is an extremely hungry one and is always feeding, and its rapidity of growth is limited only by the abundance of the food supply. It eats anything that comes in its way, is totally fearless, and is also, unfortunately, cannibalistic, eating its own kind with as great readiness as it does any other larvæ. After about ten days the larva becomes full grown, and spins up in the curl of a leaf or in any partial protection, constructing a delicate, slightly oval, but nearly spherical silken cocoon, which is attached to the leaf by silken threads (fig. 4, *e*). This cocoon is very small, in comparison with both the larva which spins it and the adult which emerges from it, and is less than one-eighth of an inch in longest diameter. The adult emerges in from ten to fourteen days, cutting off the upper end of the cocoon in a neat cap. The fly (fig. 4, *f*) is pea-green in color, with, in life, bronzy eyes with greenish reflections. The adult is a very helpless insect, does not feed at all, and remains concealed

in low grass during the day, becoming more active in the evening and depositing its eggs, so far as observed, only at this time, though perhaps also during the night. Its sole reason for existing is to deposit eggs, and having accomplished this it dies. It is a very fragile insect, and can not be handled without being crushed, but is withal rather active and difficult to catch. When taken it emits a most disgusting odor, which seems to be its chief means of protection from enemies. While the species referred to above was the common one in the orchard in question, others also occurred there. The differences between these species are so slight, however, that no one but a specialist would detect them, and the habits are practically the same for all.

Two or three species of ladybirds were also observed running about over the pear trees, the commonest one being *Adalia bipunctata* L., a little red species with two black spots on its elytra (fig. 6, e). This species was seen in the orchard with an adult Psylla in its mandibles, and in my breeding cage at Washington one or two adults cleaned the eggs from the leaves of a young pear tree about as fast as upward of fifty to seventy-five Psyllas laid them. The larvæ of the ladybird (fig. 6, a) were equally active and beneficial, and I had no difficulty in rearing a brood from the egg on the eggs and larvæ of the Psylla.

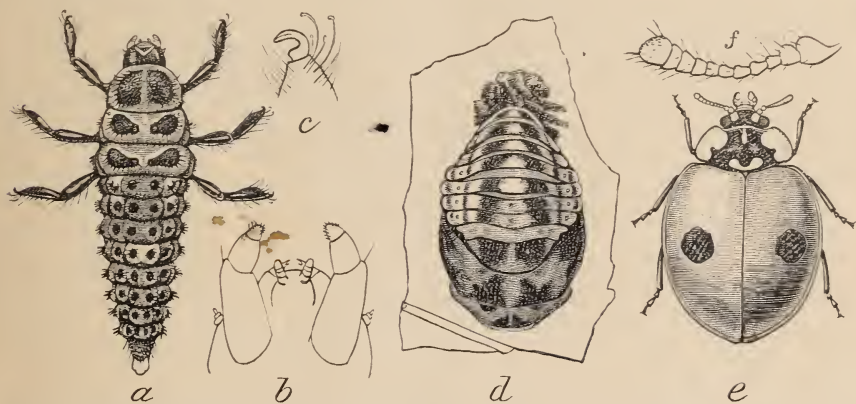
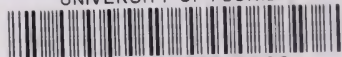


FIG. 6.—*Adalia bipunctata*: a, larva; b, mouth-parts of same; c, claw of same; d, pupa; e, adult; f, antenna of same—all enlarged (original).

REMEDIAL TREATMENTS ADVISED.

Spraying has practically no value against the adults during their active summer existence, because they are comparatively shy and at the first disturbance fly to other trees. The experience gained by Mr. Slingerland, and the results of a series of experiments conducted in Maryland, have shown that the larval periods in the life cycle of the Psylla are particularly vulnerable, and of the first brood especially so, because occurring when spraying can be most economically and efficiently practiced. Spraying to reach the midsummer broods of larvæ when the trees are in full fruit is more or less unpractical, but may be sometimes advisable, particularly with young orchards. The following treatments are therefore recommended: The first is a spring application, which should be made immediately after the leaves are well unfolded and the eggs deposited by the hibernating individuals are hatched. A thorough spraying at this time with kerosene emulsion, diluted to the normal strength with nine parts of water, or, if applied earlier, before the eggs are all hatched, with seven parts of water, will, it seems to me, effect the destruction of practically all the eggs and larvæ. Treatment at this time is especially recommended on account of the fact that it coincides with the periods for the first, or perhaps the second, application for the leaf blight of the pear, and the kerosene emulsion and the Bordeaux mixture may be com-



bined in one application with little additional trouble or expense. The experiments already conducted show the complete feasibility of this combination, which, briefly, consists in using the Bordeaux mixture in lieu of water as a diluent for the emulsion.

A second treatment, which promises well, is the winter spraying for the hibernating adults. A thorough wetting of the trunk and limbs at any time during the winter with kerosene emulsion, diluted from seven to nine times, will reach and destroy many of the insects. It will be more effective if the loose bark be scraped from the trunk and larger limbs before the application is made.

The source and means of infestation reported for the Maryland orchards are known to be paralleled in the New Jersey cases, and are probably true of the Virginia one. They emphasize the advisability, as a precautionary measure, of subjecting all nursery stock, procured either in fall or spring, to an immediate and thorough spraying with kerosene emulsion.

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Approved:

CHAS. W. DABNEY, Jr.,

Assistant Secretary.

WASHINGTON, D. C., May 1, 1895.